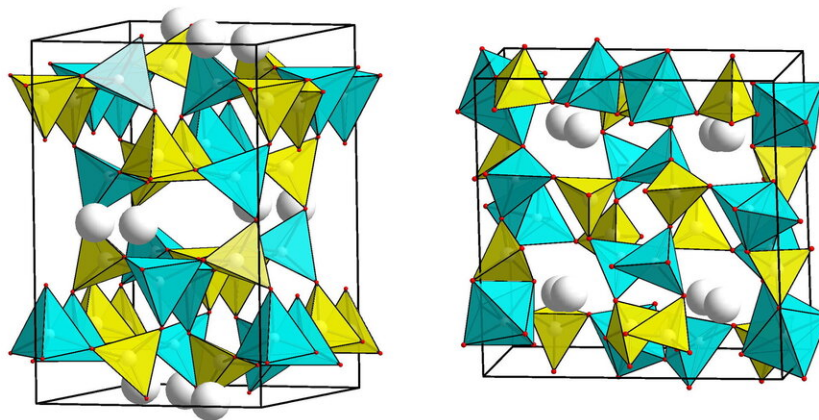


Scientists discover new forms of feldspars

June 1 2020



The crystal structure of the feldspar anorthite under normal conditions (left) and the newly discovered high-pressure variant (right). Under normal conditions, the silicon and aluminium atoms form tetrahedra (yellow and blue) with four oxygen atoms each (red). Under high pressure polyhedra with five and six oxygen atoms are formed. Calcium atoms (grey) lie in between. The black lines outline the so-called unit cell, the smallest unit of a crystal lattice. Credit: DESY, Anna Pakhomova

In high-pressure experiments, scientists have discovered new forms of the common mineral feldspar. At moderate temperatures, these hitherto unknown variants are stable at pressures of Earth's upper mantle, where common feldspar normally cannot exist. The discovery could change the view at cold subducting plates and the interpretation of seismologic

signatures, as the team around DESY scientist Anna Pakhomova and Leonid Dubrovinsky from Bayerisches Geoinstitut in Bayreuth report in the journal *Nature Communications*.

Feldspars represent a group of rock-forming minerals that are highly abundant on Earth and make up roughly 60 percent of Earth's crust. The most common feldspars are anorthite, ($\text{CaSi}_2\text{Al}_2\text{O}_8$), albite ($\text{NaAlSi}_3\text{O}_8$), and microcline (KAlSi_3O_8). At [ambient conditions](#), the aluminum and silicon atoms in the crystal are each bonded to four oxygen atoms, forming AlO_4 and SiO_4 tetrahedra.

"The behavior of feldspars under increasing pressure and temperature has been intensively investigated before, with the respect to their fate in Earth's interior," explains Pakhomova. "Feldspars are known to be stable only at pressures of up to 3 gigapascals along the common pressure-temperature profile of the Earth, while they decompose into denser minerals at higher pressures." 3 gigapascals (GPa) are equivalent to 30,000 times the normal air pressure at sea level. "However, under cold conditions feldspars may persist metastably at pressures higher than 3 GPa," adds Pakhomova. "Previous high-pressure structural studies of feldspars at [room temperature](#) have shown that the tetrahedral framework of feldspars is preserved up to 10 GPa."

The scientists subjected common feldspars to pressures of up to 27 GPa and analyzed their structure at the Extreme Conditions Beamline P02.2 of DESY's X-ray light source PETRA III and at the Advanced Photon Source (APS) in Chicago. "At pressures above 10 GPa, we have discovered new high-pressure polymorphs of anorthite, albite and microcline," reports Pakhomova. "The [phase transitions](#) are induced by severe geometrical distortions of AlO_4 and SiO_4 tetrahedra, which result in the aluminum and [silicon atoms](#) gaining additional neighboring atoms and also in the formation of denser frameworks based on polyhedra where one aluminum or silicon atom is bonded to four, five or six

[oxygen atoms.](#)"

To investigate the stability of the discovered high-pressure variants of feldspars at high temperatures and their possible persistence in Earth's interior, the scientists performed a series of high-pressure-high-temperature experiments at the Bayerisches Geoinstitut. It turned out that the high-pressure variant of anorthite persists at temperatures up to 600 degrees Celsius at 15 GPa.

"Such pressure-temperature conditions could be found on Earth in the subductions zones—regions where two lithospheric plates collide, one riding over the other," explains Dubrovinsky. "In such geological settings, feldspars are delivered into Earth's interior along with other crustal material by the descending plate. Our results indicate that in cold subduction zones, if the [temperature](#) does not rise above 600 degrees, high-[pressure](#) phases derived from feldspars could persist at depths corresponding to Earth's upper mantle. This could possibly influence the dynamics and fate of cold subducting lithospheric plates and alter seismological signatures."

More information: Polymorphism of feldspars above 10 GPa; Anna Pakhomova, Dariia Simonova, Iuliia Koemets, Egor Koemets, Georgios Aprilis, Maxim Bykov, Liudmila Gorelova, Timofey Fedotenko, Vitali Prakapenka, Leonid Dubrovinsky; *Nature Communications* (2020). [DOI: 10.1038/s41467-020-16547-4](https://doi.org/10.1038/s41467-020-16547-4)

Provided by Deutsches Elektronen-Synchrotron

Citation: Scientists discover new forms of feldspars (2020, June 1) retrieved 29 June 2024 from <https://phys.org/news/2020-06-scientists-feldspars.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.